NUTRIENT MANAGEMENT IMPLICATIONS OF RELAY CROPPING ON THE ENVIRONMENT

J.F. Shanahan, D.D. Francis, and J.S. Schepers
USDA-ARS, Lincoln, NE

Abstract

Residual nitrogen (nitrate-N) remaining in the root zone after seed corn production is frequently greater than under commercial corn production. This nitrate is subject to leaching into the shallow ground water of the Platte River Valley in South-Central Nebraska, as noted by elevated nitrate-N concentrations under seed cornfields compared to other fields. Hard-red winter wheat was planted into seed corn residue in early October of 2001 as a cover crop to scavenge residual-N from the root zone and thereby reduce the potential for nitrate leaching. Soybean was inter-seeded in the wheat in early June and wheat was harvested in early July. Soybean plants emerged from the wheat stubble and matured in late September. Nitrogen uptake by wheat amounted to 130 lb/acre (90 lb N/acre from 68 bu/acre yield). The subsequent soybean crop that yielded 55 bu/acre functioned as a second scavenger crop. A second attempt at relay cropping was initiated in October of 2002 after harvest of center-pivot irrigated seed corn. Residual-N in the root zone prior to planting wheat ranged from 31 to 111 lb N/acre and between 9 and 42 lb N/acre after harvest.

Introduction

Producers are continuously fine-tuning their production practices, seeking ways to use labor and capital more efficiently and increase profits while protecting the environment. This includes making better and more efficient purchasing decisions and developing improved marketing strategies to create more profit from their farming operation. This paper describes a production concept that involves "thinking outside the box" for Nebraska relative to standard continuous corn or corn/soybean production systems. The concept of relay cropping is not new to the area, but the practice is seldom used because of climatic limitations (timeliness and amount of precipitation and short growing season). Yet, the idea has significant economic merit and the environmental implications are very positive if producers can find ways to overcome the challenges. Relay cropping is essentially a special version of double cropping, where the second crop is planted into the first crop before harvest, rather than waiting until after harvest. In this way, the second crop can take advantage of a longer growing season.

This seemingly workable scenario was observed by Jim Schepers in Southeast Argentina in March 2001, where a farmer had planted winter wheat into corn after harvest. The drill he used to plant the wheat had been adjusted to 7.5-inch row spacing. The producer had plugged seed delivery to every 4th row so that no wheat seed was delivered in the area of the standing corn stalks (30-in row spacing). About one month before the wheat was ready to harvest, he inter-seeded soybeans into the wheat with a make-shift planter mounted behind a small tractor that had narrow tires that would fit within the 15-inch openings left when the wheat was planted (soybeans were planted in the area of the old corn row). At the time of wheat harvest, the soybeans were 6 to 8 inches tall, so they were not affected by the harvesting operation. Yields of the wheat and soybean crops in Argentina were 80 to 90% of full yield compared to when only one crop was planted.

The objective of this study was to introduce the relay-cropping concept observed in Argentina into a seed corn/soybean rotation under center-pivot irrigation in Nebraska to use the winter wheat cover crop as a scavenger of residual N and hopefully protect the groundwater for nitrate leaching.

Materials and Methods

In the fall of 2001 after center-pivot irrigated seed corn harvest, the stalks were chopped with a rolling stalk cutter to incorporate a portion of the residue and reduce the ridge/furrow effect. During the first week of October wheat (Wesley cultivar) was planted in two 10" rows between the 30" cornrows. No wheat was planted on the top of the ridge where corn had been growing. This area was preserved for soybean inter-seeding the following spring. In early June of 2002 shortly after the wheat headed Roundup Ready soybeans were inter-seeded into the wheat (20" wide area in the location of the previous corn plants) using a conventional 12-row planter behind a track-type tractor with tracks centered on a 90" spacing. Wheat was harvested in early July using a 30' grain platform attached to a combine with duals that permitted one row of soybean to pass between the tires. Soybean plants were 8 to 10" tall at the time of wheat harvest.

In the fall of 2002, the relay-cropping concept was moved to a companion field that was part of the original seed corn/soybean rotation. This field was also under center-pivot irrigation. Wheat or barley strips were seeded into corn stalks that had been tilled with a rolling stalk cutter. The winter cover crops were planted in early October in two 10" rows between the recently harvested cornrows as in 2001

Soil samples in the fall of 2001 and 2002 were collected to a depth of 3' by a consultant hired by the producer. The second field was sampled to a depth of 5' using a hydraulic probe in November of 2002 and late July of 2003 after wheat harvest.

Results and Discussion

The growing season in Argentina (Mar Del Plata area) where they were developing the relay-cropping system is longer than in Nebraska (more like southern Kansas or Northern Oklahoma). Aside from the soils being less fertile than many in Nebraska, it seemed that such a system might work for seed-corn producers in Nebraska. The farmer in Argentina emphasized the importance of having center-pivot irrigation to get the crops started and in case of subsequent water stress. The challenge in bringing the concept to Nebraska was determining how to adapt the relay cropping system for Midwest crops, equipment, and climate. Seed corn production was the targeted cropping system because the crop is harvested early enough for timely seeding of the wheat. The goal to use wheat as a scavenger crop to remove the residual N left in the soil after seed corn harvest was successful in that residual N amounted to 150 lb N/acre (3-ft sample) after seed corn harvest and 35 lb N/acre after soybean harvest one year later. No N was applied to the wheat at planting or during the growing season. Nitrogen removed in the wheat grain amounted to 90 lb/A that could have otherwise leached beneath the root zone. Another 40 lb N/acre was taken up and remained in the straw after harvest.

The secondary goal was to provide additional income to producers if we could work out the planting and harvesting logistics. The relay-cropping concept has significant economic merit and the environmental implications were very positive after the first year. First year results with seed corn rotation showed the wheat crop yielded 68 bu/acre in July of 2002 and removed 130 lb N/A from the soil. The additional residue produced (~2 T/acre) by the wheat will build soil organic matter content. First year results showed that the producer increase his profitability by about $100/A, even after experiencing a 15% reduction in soybean yields (~10 bu/A).

Hard-red winter wheat yields in 2003 ranged from 55 to 75 bu/acre field averages. Observations by producers were that the isolation areas around the perimeter of seed fields (~90-ft wide) yielded up to 20% higher than in the bulk field where seed corn was previously grown. These isolation areas are usually either planted to wheat, soybean, or sorghum. Reasons for higher wheat yields in the border areas area are not certain, but could hold the key to enhanced profitability from the inter-cropping (relay-cropping) scenario. A comparison of grain between the isolation area and bulk field indicated the presence of scab in the bulk field. The occurrence of scab is known to increase with humid conditions during the boot stage. Other possible explanations could involve atrazine carry-over after seed corn, N immobilization by the corn stalks, seedbed and planting differences, levels of residual N (nitrate-N) in the bulk field vs. border, and planting date. Producers also note that plants in the border areas are more vigorous in the early growth stages and more erect at harvest.

Nutrient management is an important component of the relay cropping system since each crop has a different nutrient requirement. Wheat requires higher soil test levels of phosphorus (P) than corn or soybeans. Past research results have indicated that P mainly increases tillering in fall, which increases the number of heads harvested, and thereby, grain yields. The positive effect of P on wheat rooting is also often associated with reduced winterkill. It is recommended that P fertilizer be placed directly with or very near the wheat seed. Phosphorus fertilizers placed with the seed generally will have a negligible effect on wheat stands because of their low salt content. Potassium (K) is usually very high in Nebraska soils and only a few would require K addition. Good soil sampling and testing for P and K are necessary in this high management cropping system to maximize profits.

Summary

Relay cropping has the potential to reduce nitrate leaching, increase carbon sequestration, and increase profitability for seed corn producers. It does so by providing a crop to capture residual soil nitrate and solar energy during the seven months when summer annual crops normally are not growing. Work in Argentina suggests that center pivot irrigation is essential for consistent success in relay cropping. Irrigation assures the rapid germination and establishment of the small grain crop in the fall and also the rapid germination, establishment, and survival of the under seeded soybean crop. Important components of relay cropping include choosing the best small grain and soybean varieties, minimizing wheel traffic damage and compaction during relay intercrop planting and small grain harvest, and minimizing soybean injury by the combine cutter bar during small grain harvest.

Current consideration is also being given to expanding the relay cropping concept into commercial corn and soybean rotations. In order to facilitate timely planting of wheat, ways to shorten the growing season of commercial corn production such as using shorter season hybrids and using herbicides as harvest aids to speed the dry down of corn are being explored. An additional problem when moving to rotations with commercial corn production is determining the best way to deal with the high volume of residue produced by the corn.

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Program Chair:
John E. Sawyer
Iowa State University
Ames, IA 50011
(515) 294-1923

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772 – 22nd Avenue South
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